Decision-Making Techniques

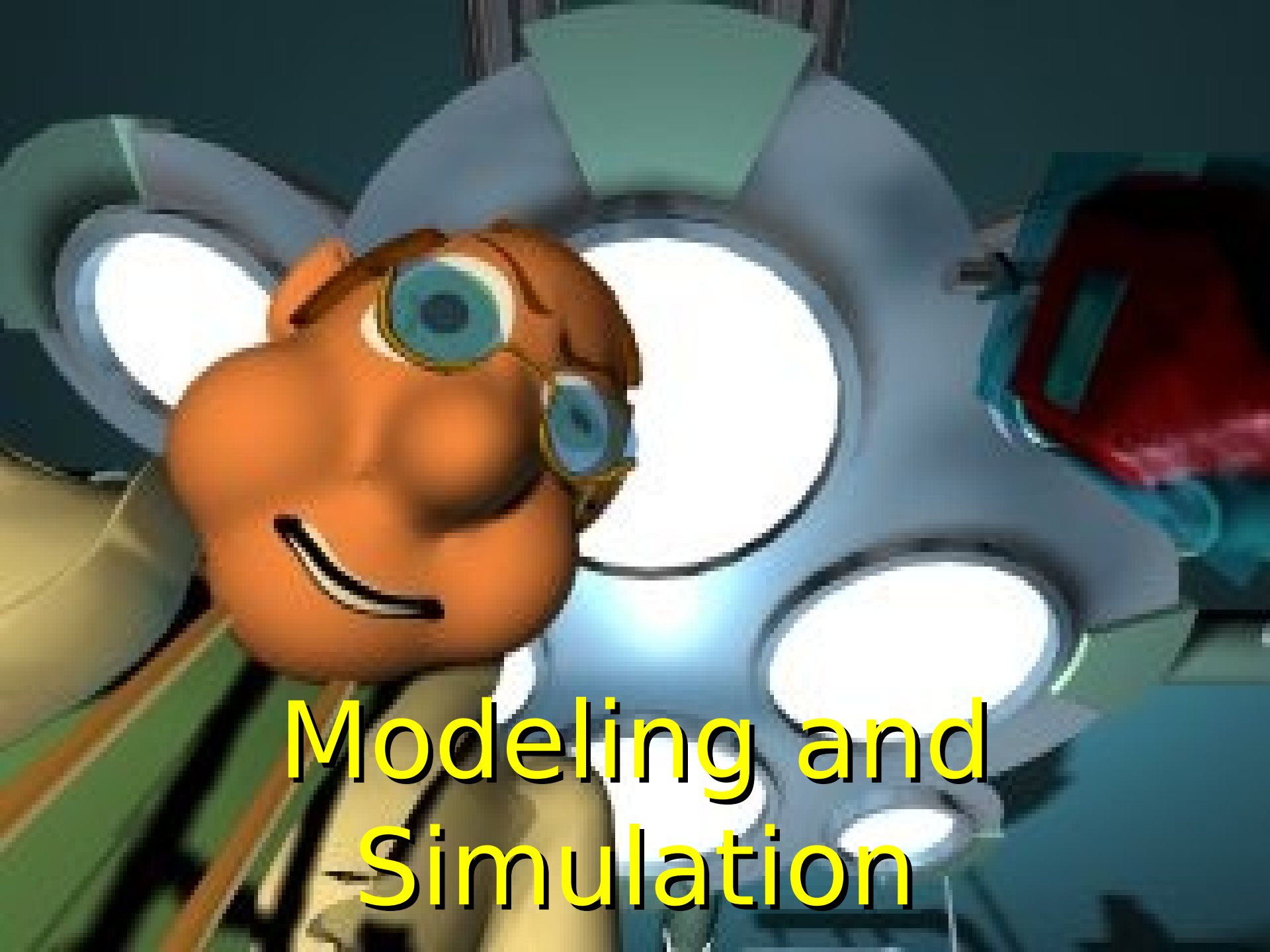
March 6, 2003

Objectives

- Describe various decision support techniques/tools
- Understand their uses and limitations
- Select the best tool for the situation

Decision Making Tools

- Modeling & Simulation
  - Linear programming
  - Queueing theory
- Forecasting
  - Regression analysis
- Decision analysis
  - Decision trees
- Risk analysis
- Sensitivity analysis


Modeling and
Simulation

Models

- A set of assumptions and approximations about how a system works

Advantages of Models

- Faster, easier, cheaper and safer than studying the system
- Safely experiment with wide-ranging ideas

Types of Models

- Physical (ionic) models
  - Table-top models
  - Flight Simulators
- Logical (mathematical) models
  - System’s operations
  - Computer simulation

Studying Logical Models

- Use of traditional mathematical equations
  - Linear Programming
  - Queueing theory

What is Simulation?

Model design of an actual or theoretical physical system, execution on digital computer, and analysis of the output

Computer Simulation

- Refers to methods for studying a wide variety of models of systems
- Suited for complex models

Examples: Risky Business, Theme Hospital, MedModel

Advantages

- Identification of peak workload requirements
- Adjustment of staffing patterns:
  - increase efficiency
  - decrease wait times

More Advantages

- Flexibility to model systems, even if they are complex and messy
- “Real time” scenarios
- Computing/cost ratios
- Statistical design and analysis

Limitations

- Does not provide real answers, only approximations and estimates
- Standard statistical methods seldom work

Items Examined in Simulation Studies

- Business hours
- Patient arrival times
- Staff shifts and breaks
- Optimal staffing
- Queueing

Steps to Performing a Simulation Study

- Establish goals & objectives
- Formulate & define model
- Collect data
- Build, verify & validate model
- Experiment and analyze results

Linear Programming

- An approach that has been developed to maximize or minimize a program output, subject to program constraints

Linear Programming Example:

Ambulance Services

- Ambulance Services: LA County wants to determine the optimal way to provide emergency ambulance services to three low income areas of Los Angeles

Ambulance Services Available:

- Schaefer
- Goodhew
- Medivac

- Also required
  - response times to each hospital
  - ambulance charges for trips

Hospitals with E.R.s

- Martin Luther King (MLK) (75)
- USC County General (USC) (175)
- Daniel Freeman (DF) (35)

Objective

The primary goal of the County is to provide emergency services to the largest number of people possible.

Budget

43,750 to spend on these services.

Minimum Allowable Performance Requirements:

- overall average transportation time must be no longer than 45 minutes
- no ambulance service is to receive less than 15% of the patient assignments
- no hospital is to receive less than 10% of the patient treatments

Constraints

- Budget
- Transportation time
- Ambulance minimum assignment percentage
- Hospital minimum assignment percentage
- Capacity

Basic Assumptions of Linear Programming:

1. Linear objective function
2. Linear constraints
3. Non-negative variables

Queueing Theory

- A body of knowledge useful for examining the nature of waiting lines

Queueing Models: Structure

- Arrival Process - distribution of interarrival times times
- Service Process - distribution of time required to serve a customer
- Service Discipline - how customers are served
- Capacity of Queue - limit on # waiting
- Number of Servers - single/multi server
- Network Structure - output from one queue inputs to another queue

Modeling and Simulation Applicability

- Demand for services
- Cost reimbursements
- Facility designs
- Different ways that health care services can be provided

Measures:

- Facility costs
- Operating costs
- Patient throughput and wait times
- Staff utilization

Example of Modeling and Simulation Software

- “You cannot memorize understanding. You must construct it.”

Forecasting

Forecasting

- For what purposes are forecasts required?
- What quantities or events require prediction?
- What information & resources are available as a basis for forecasting?

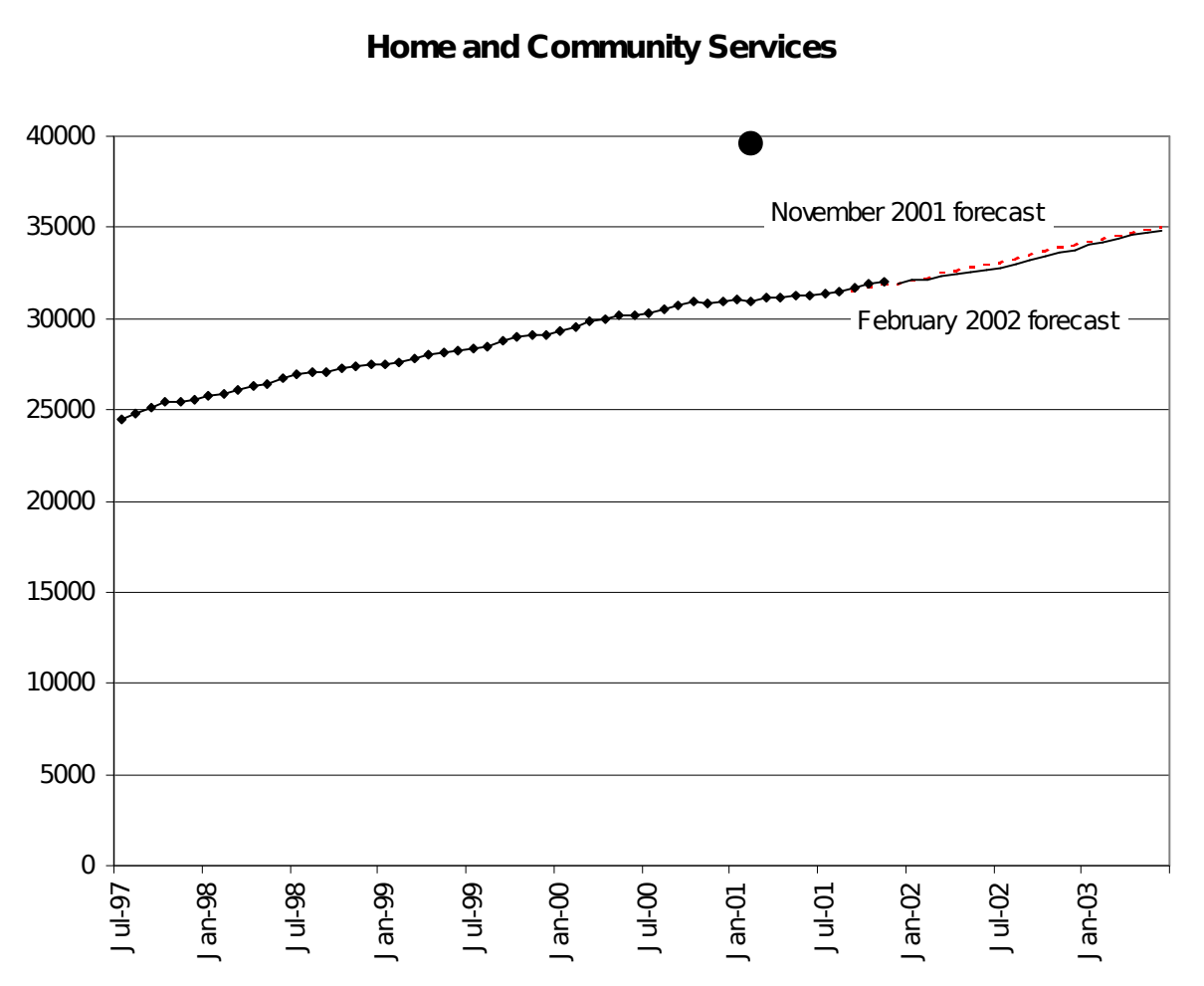
Forecasting: Limitations

- Some uncertainty will remain
  - unexpected developments
  - predicted events never materialize
  - large forecasting error
  - mistakes in timing

Data Sources

- Data mining
  - Surveys
  - U.S. Census
  - Data Warehouses (HCFA, DHHS, TRICARE, NIH, CDC, etc.)

Forecasting Example



Regression Analysis

- Marketing managers need to make predictions about situations affecting the company and may use a regression equation.

Regression

- Techniques for describing the relationship between two continuous variables (dependent & independent) associated with one another in a linear fashion

Purpose

- To determine the linear or non-linear ***relationships*** between the variable of interest and the auxiliary variable(s).
- Use for predicting/forecasting the values of the variable of interest with different values of auxiliary variable(s).

Regression Analysis

- Bi-variate Regression Analysis is a statistical technique which analyzes the linear relationship between two variables by estimating coefficients for an equation for a straight line.
- One variable is the dependent variable and the other is the independent variable and they can be deterministic (relatively seldom).

Models of Linear Regression

- Simple linear regression (Classical t-test)
- Multiple linear regression (more than 1 predictor variable)

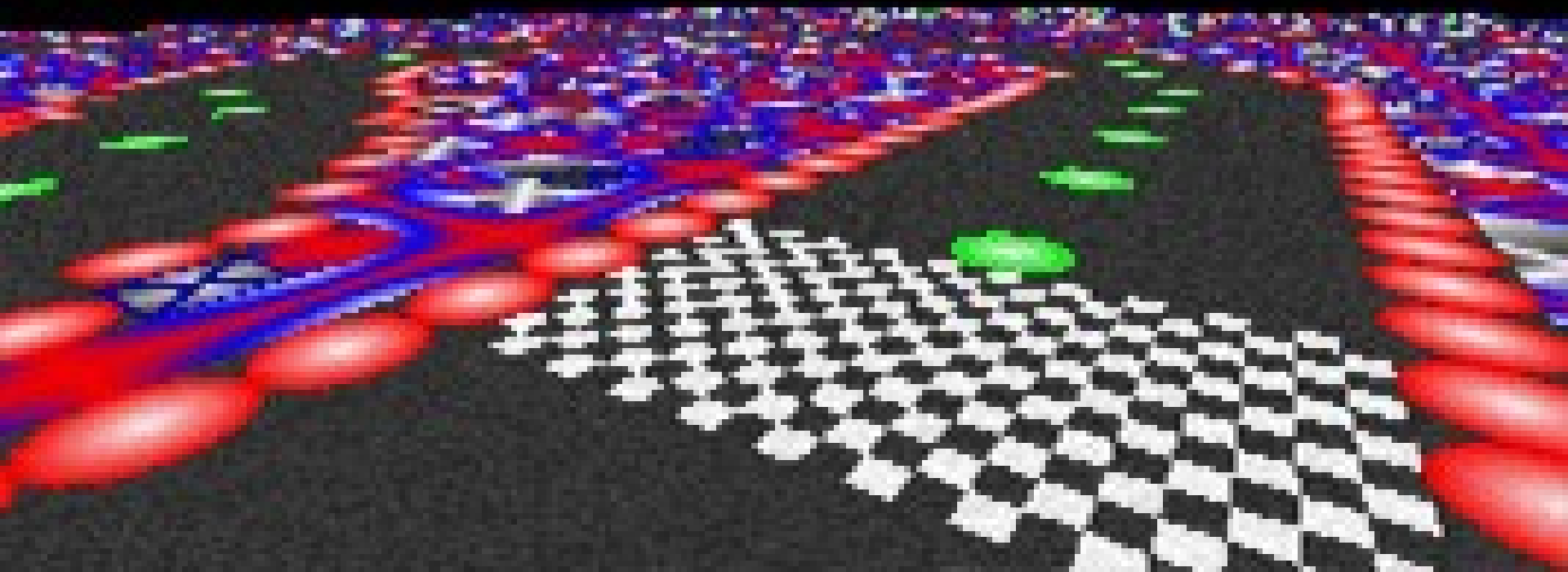
Example of Applications

- Predict the effects of alternate fertility levels on demography, economics, education, health, urbanization, and agriculture

Limitations to Regression Analysis

- Large numbers are needed
- Mathematical outcome excludes real-world political influence
- Design and rationale flaws
- Replication of study

Decision Analysis



Methods of Modeling Decision Analysis Problems

- **Decision Trees**
  - Branching structures that represent potential future events
- **Influence Diagrams**
  - Factors that can affect outcomes

More to come on decision analysis and decision trees next week!

Risk Analysis

Risk Analysis

- Standard structured process to evaluate and manage risks
- Likely to be used by ‘responsible’ authority

What is Risk?

- Different outcomes possible
- One (or more) outcomes unwanted
- Uncertainty of outcome

Components of Risk Analysis:

- Identification of risk
- Risk assessment
- Risk management
- Risk communication

Hazard Identification

- A hazard may be a thing or a process:
  - pathogen, toxin, residue
  - Outcome

The Right Questions

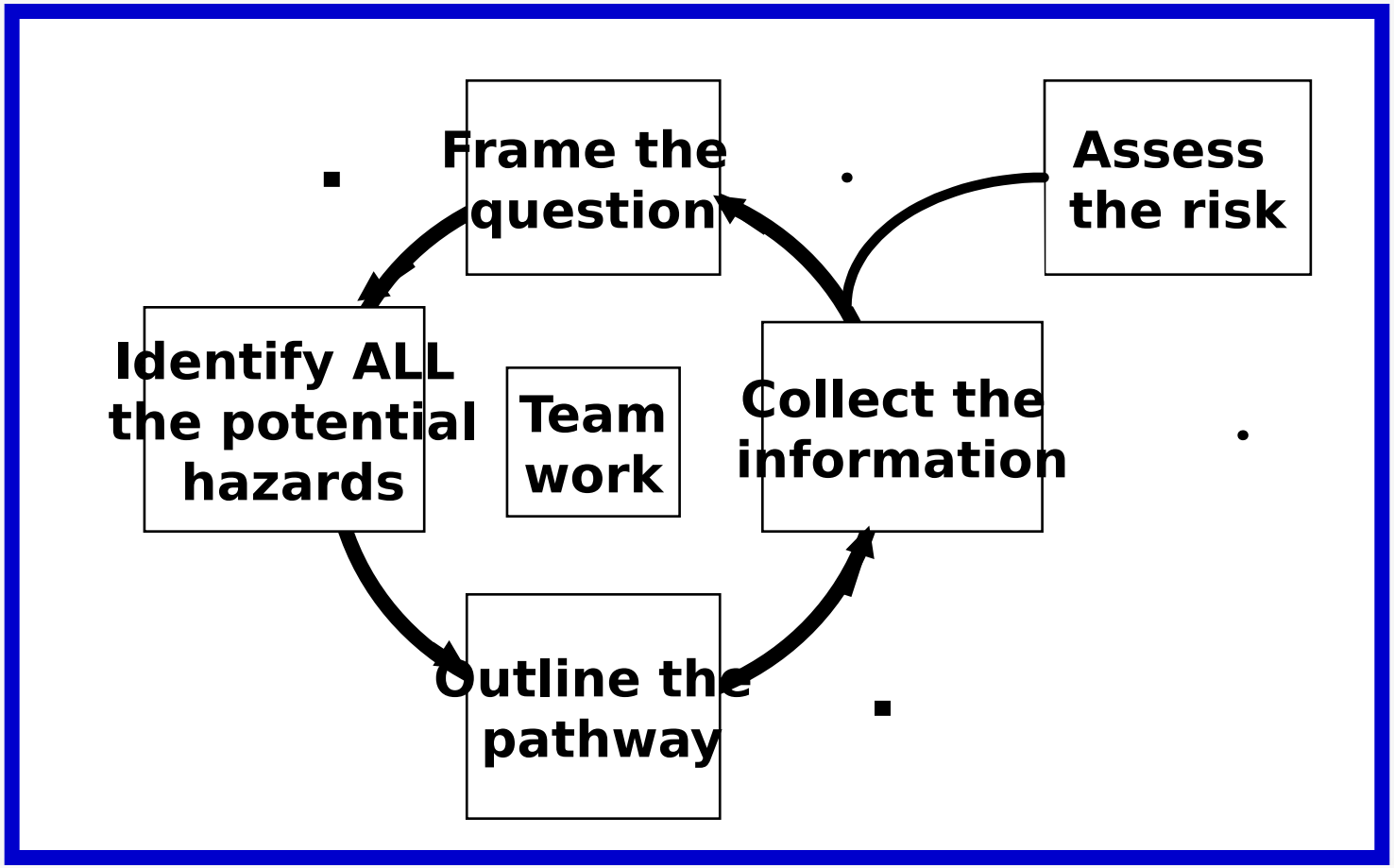
- What is the likelihood of occurrence?
- What is the potential impact?

A risk is significant if it has a reasonable likelihood of occurrence and a large potential impact.

Principles of risk Assessment

- Risk assessment is the estimate of a risk
- Risk is the probability of an (unwanted) outcome
- May be qualitative or quantitative
- Unwanted outcome(s) must be clearly defined
- Gives information, NOT SOLUTIONS!

Process of Risk Assessment



What Will a Risk Assessment Provide?

- An estimate of risk!
  - plus an estimate of uncertainty
- Identifies essential data deficiencies
  - target research and info gathering
- Sensitivity testing

Risk Management

- Use of information:
  - assessed risks
  - assessed benefits
  - assessed costs
  - stakeholder requirements
- To find ‘acceptable risk’
  - at community/society level
  - won’t please all!

Key Issues in Risk Communication

- Scientific uncertainty - lack of scientific background (general public)
- Pre-existing bias
- Media presentation - bad news sells
- Trust/mistrust in information source

Sensitivity Analysis

- Technique used to determine how the result of a decision changes when some of the parameters or assumptions change.
- An analysis of the consequences of possible prediction

Practical Uses

- Can be used with
  - Models
  - Simulations
  - Forecasting
  - Decision Analysis

Example

Determine how the financial break-even point changes when some factors (such as fixed costs, variable costs, or revenue) change.

Additional Information and Resources:

- Modern Healthcare: An online journal for healthcare executives
- Health System Model: An examination of the physician and nursing work force